Space Weather Technical Forecast

Issued on Friday, 07 July 2023 at 13:36 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1/R2 radio blackouts. G1/Minor Storm to G2/Moderate Storm possible today with CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M-class flare reaching M4.0 at 07/0629UTC from AR3359, which is located in the southwest. There are nine numbered sunspot regions on the visible disc. AR3363 is the largest region on the visible disc, and is still close to the southeast limb. Most of the regions have shown little significant change in recent hours. A filament eruption from the northeast around 06/2100 UTC has resulted in a Coronal Mass Ejection (CME), however this does not appear to be Earth-directed from available imagery.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, was predominantly at slightly elevated levels, and on occasion reached elevated levels and is currently at 480 km/s. Total magnetic field strength remained at moderate levels, between 8-12 nT and is now on a declining trend and close to weak levels. The north-south component, Bz, has mostly varied weakly through much of the period, and was often negative The phi angle was positive (towards the Sun) throughout. Geomagnetic activity has been Quiet to Unsettled Kp 2-3) with an active interval towards the end of the period, probably as a result of the weak arrival of the anticipated CME. The solar wind parameters also probably indicate a weak connection to coronal hole 20, which was previously discernible on imagery.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was at background to moderate levels, with a peak of 636 pfu at 06/1720 UTC. The 24-hour integrated fluence started on a declining trend, below the Active (1e8 integrated pfu) threshold, and is now steady. A fluence of 1.612e7 pfu was recorded at 07/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is forecast, with a chance of M-class flares. A number of regions rotating onto the visible disc, through the forecast period, may increase activity. Further filament eruptions may occur and there is a slight risk of an X-class flare.

Solar Wind / Geomagnetic Activity: A partial halo CME from a filament eruption near AR3359 on 04 July appears to hve weakly arrived at Earth. Solar winds are forecast to b slightly elevated to elevated and may reach 550-600km/s later today due to a connection to coronal hole 22, before a decline to slightly elevated levels by day 4. Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) with a risk of G1/Minor or G2/Moderate (Kp 6 or 7) storms today and tomorrow due to the CME , and to a lesser extend coronal hole influence. Through day 4 (10th) Quiet to Unsettled (Kp 1-3) conditions are expected.

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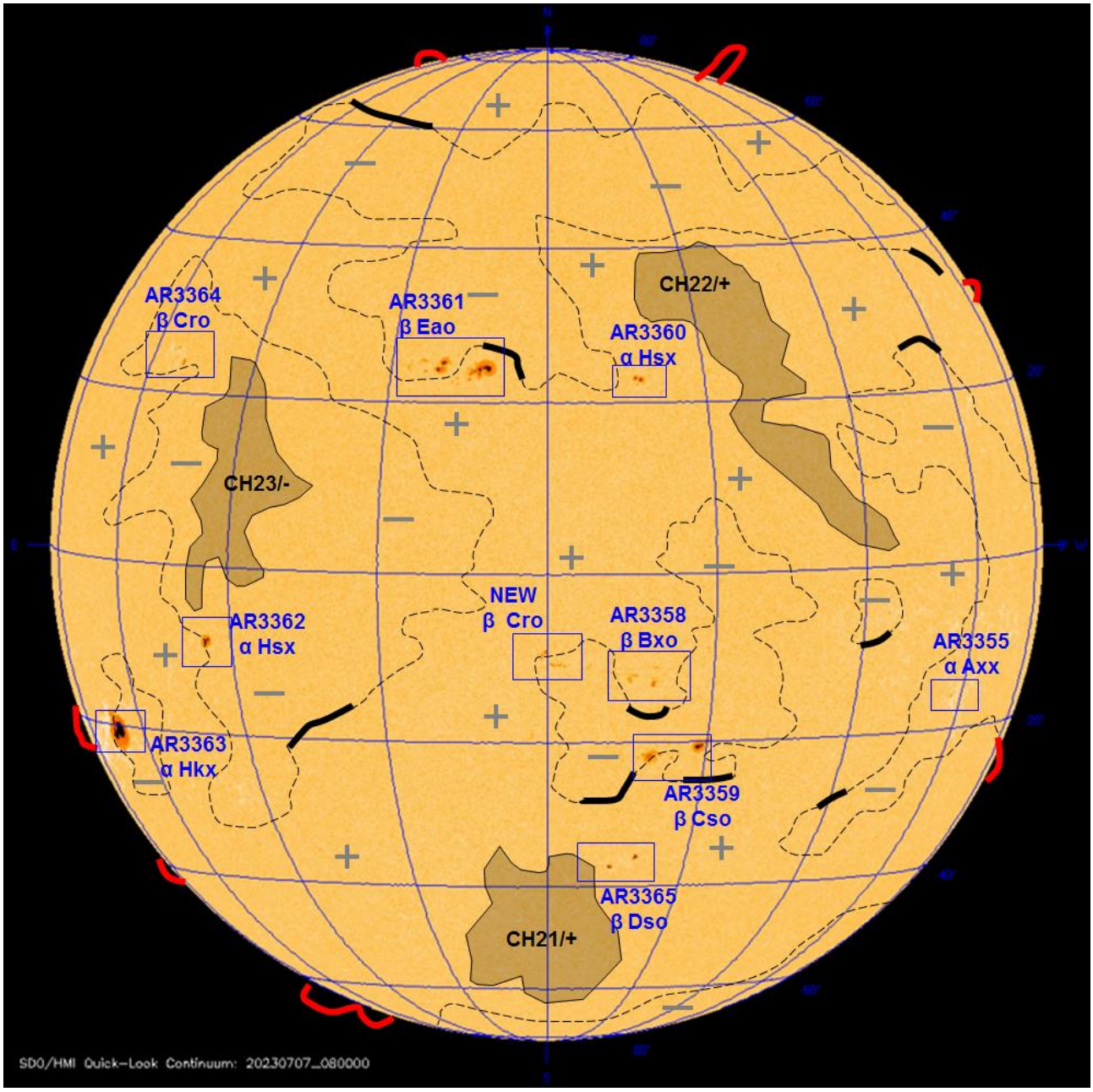
Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period. High energy electron flux (greater than 2MeV) is expected to remain at background to moderate levels today and tomorrow due to the geomagnetic enhancements, then from day 3 (9th) a steady increase in diurnal peaks is likely, probably breaching the High threshold (1000 pfu). Electron fluence is expected to continue to decline at first, but later in the forecast period show an increase as a response to the HSS from CH22. However, the fluence is still likely to remain below the Active threshold (1e8 integrated flux) throughout the period.

Figure 1. Solar Analysis Valid 0800 UTC, 07 July 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

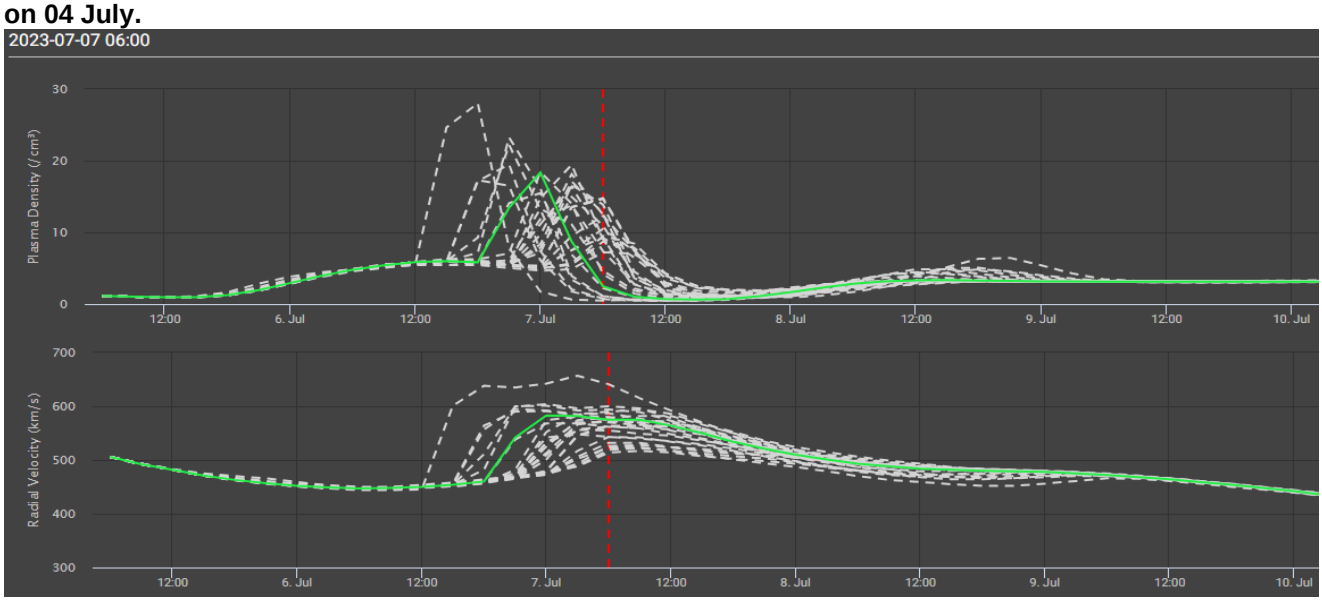
A partial halo CME which left the Sun on 04 July, appears to have arrived Earth as a rather weak feature, butt with low confidence in the actual arrival time. In addition to the CME coronal hole 22 is due to connect with the Earth today, this most likely to occur late today, Therefore the solar wind is expected to start at slightly elevated levels to become elevated or possibly strong through today, then decline to slightly elevated levels by day 4. Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) with a risk of G1/Minor or G2/Moderate (Kp 6 or 7) storms today and tomorrow due to the CME, and to a lesser extend coronal hole influence. Through day 4 (10th) Quiet to Unsettled (Kp 1-3) conditions are expected.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	30	5	1
Strong	G3	No	10	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1000	Partial Halo	Filament Eruption	SE quadrant	550 km/s	06/0000UTC	Low confidence in arrival time

Figure 2: Met office ENLIL ensemble guidance, showing likely arrivals times for CME that left the sun on 04 July.



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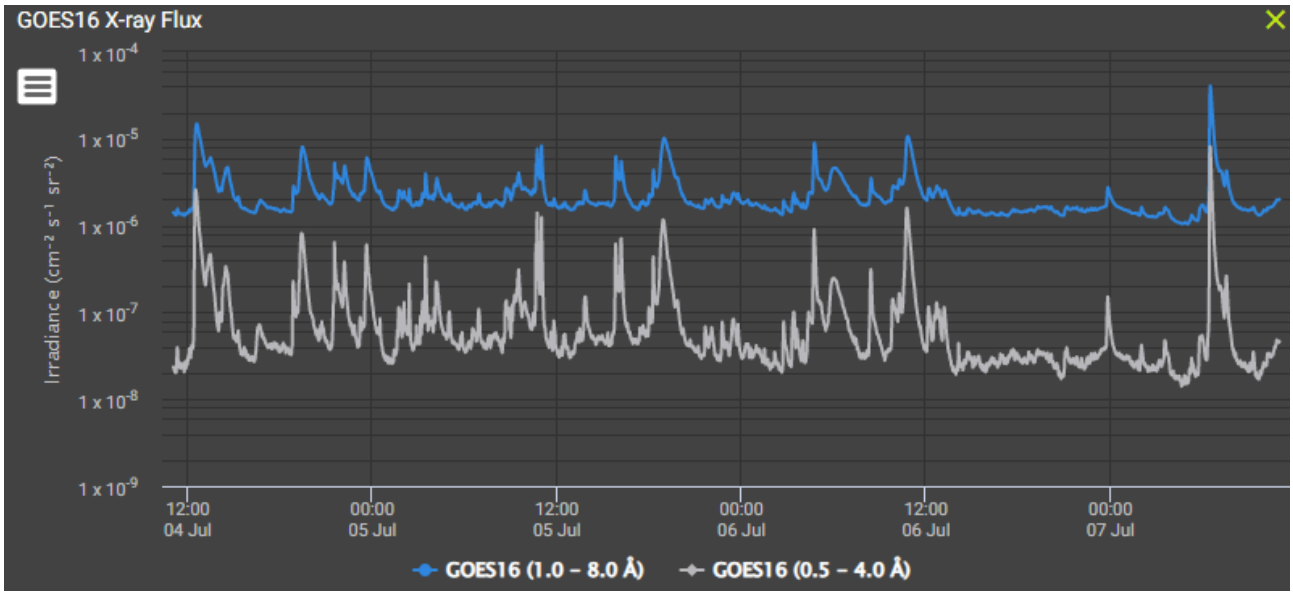
Radio Blackouts - X-Ray Flares:
Solar activity is Moderate, with an M4.0 flare observed from AR3359 at 07/0629 UTC. There are 10 sunspot regions on the visible disc, 9 of which are numbered. Of these AR3359 and AR3361 are probably the most complex regions, having displayed beta-gamma magnetic configuration through the past 24 hours. However the largest region is AR3363 which has recently rotated onto the visible side of the Sun. There is a new and unnumbered, small and relatively simple region in the southwest. Most of the regions, have shown little significant change over the past 24 hours. Only AR3355 and AR3358 have shown a very slight increase in spot number and size or complexity. Low to Moderate activity is likely flares with a slight chance of an X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	40	40
Very Active	R3 to R5 X Class	No	5	5	10	10

Figure 3: X-ray flux at GEO from GOES showing C-class and M-class flares in past 3 days.



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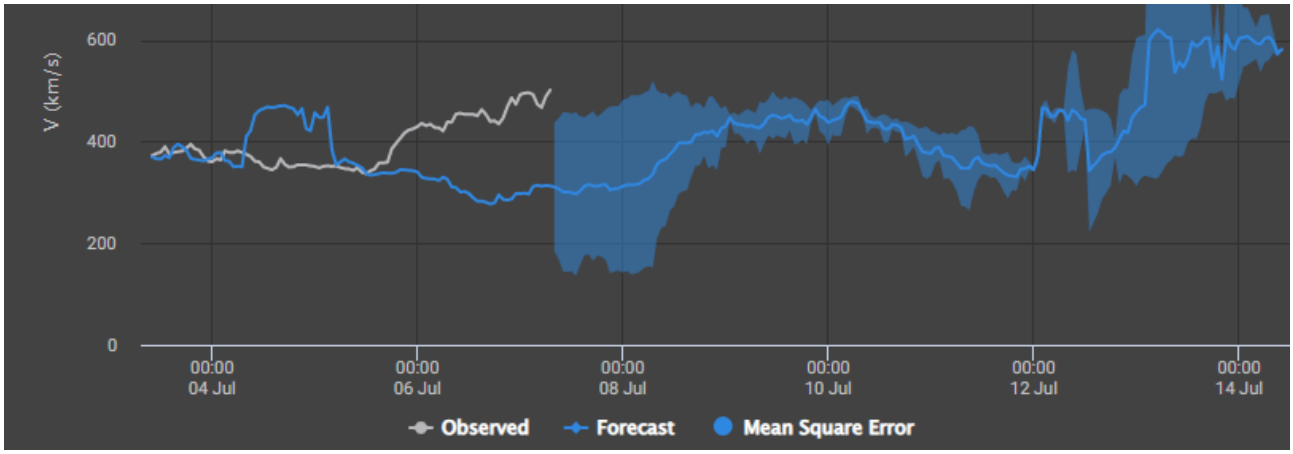
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight chance of S1/Minor storm levels being reached through this period, as the current regions on the disk do not pose a significant risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Met Office Solar Winds Prediction Model (SWPM) showing anticipated levels not including CME arrivals.



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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to remain at background to moderate levels today and tomorrow due to the geomagnetic enhancements. From day 3 (9th) a steady increase in diurnal peaks is likely, probably breaching the High threshold (1000 pfu). Electron fluence is unlikely to change too much in the next couple of days before then showing an increase in response to the HSS from CH22. However, the fluence is still likely to remain below the Active threshold (1e8 integrated flux) throughout the period. The Met Office REFM guidance is considered to be offering poor advice, with the fluence remaining below the Active threshold preferred for day 1.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	20	30	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM guidance,

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